



COLOR-BLINDNESS AND DEFECTIVE SIGHT AMONG RAILROAD EMPLOYÉS.

JANUARY 8, 1879, in the House of Representatives of the Legislature of Massachusetts, Mr. Hamilton A. Hill, of Boston, introduced, at the request of Dr. B. Joy Jeffries, the following order:—

“That the committee on railroads inquire whether any and (if any) what legislation is necessary in reference to the employment by railroad companies in certain responsible positions of persons affected with color-blindness.”

This order was passed, and at a public hearing January 22, 1879, Dr. Jeffries argued in support of the conclusions contained in his book on “Color-Blindness: Its Dangers and its Detection.” In this book, page 279, he also holds that a law of control should, as in Europe, require the proof by test of normal visual power for *form* as well as normal color-sense. The result of this hearing was the following resolve:—

Resolved, That the board of railroad commissioners be instructed to consider whether any legislation is expedient or needful with reference to the employment by railroad corporations of persons afflicted with color-blindness, and report thereon to the next General Court. (Resolves, 1879, chap. 30.)

January 16, 1880, Mr. Hamilton A. Hill, of Boston, introduced in the House of Representatives of the Legislature of Massachusetts, at the request of Dr. B. Joy Jeffries, the following order:—

“That the railroad committee inquire whether any and (if any) what legislation is necessary in reference to the employment by railroad companies in certain responsible positions of persons not having normal or the average visual power.”

This order was passed, and the joint standing committee on railroads gave a hearing upon it February 2, 1880, and two subsequent days. Dr. B. Joy Jeffries appeared, and argued in favor of the *first* of the final conclusions of the board of railroad commissioners in their eleventh annual report, in reference to color-blindness. This conclusion is the same he argued for in the hearing before the previous committee, January 22, 1879, namely:—

(1.) That the existence of color-blindness, total and partial, is a well-established fact, and that there are men who, by reason of such defect, are unfit for positions on railroads requiring ability to distinguish color signals.

Against the railroad commissioners' second conclusion, namely, (2) That the extent of dangerous color-blindness, that is, such color-blindness as unfits persons for railroad employment, has been greatly exaggerated, and that a very small per cent. of persons are, for this reason, unfit for such employment, Dr. Jeffries argued that, as all degrees of color-blindness were dangerous, the danger was in proportion to the extent. His careful examinations of nearly thirty

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thousand people showed that this defect existed here, as in Europe, in about four per cent. of males, whilst with females it was very rare. He thought that expert testing of railroad employés would show that color-blindness existed among them, as in Europe, to at least three per cent. Expert tests will also show that these three per cent. are dangerous to railroad traffic. How that danger was concealed from the commissioners he explained, and referred especially to his volume, pages 147-157, and the portion reprinted in the Report of the Railroad Commissioners of Connecticut, page 61. This point he illustrated by the color-blind themselves, by absolute experiment, as he had to the previous committee. The need of expert testing is shown by the fact that those who are not experts cannot prove to the railroad officials and the community the danger from *all* these color-blind.

Against the commissioners' conclusion, (3) That examination may be properly made by persons not medical experts, and that such examinations will certainly be sufficient if doubtful cases are referred to such experts, he brought the evidence of the Surgeon-General of the United States Army, Navy, and Marine Hospital Service, in their directions for testing for color and form perception by medical officers *only*, who are to study Dr. Jeffries' volume, issued to them as a standard authority. Direct testimony was given on this point by Colonel J. F. Head, M. D., United States Army. His experience and opinion were wholly corroborative of Dr. Jeffries' position. Dr. Jeffries' volume was referred to as showing that all government and railroad corporations who had carried out this control had found from experience the necessity of experts to decide justly between the community and the employé. *There is no testimony from Europe or England that any railroad official or non-medical man has this work given to him.* The official replies received by the commissioners from Sweden and Holland correspond to the statements in his volume, and are explicit on this point. This is still further shown by the accompanying letters. How laymen investigating this subject without expert assistance might very readily be mistaken Dr. Jeffries showed in great detail. In Europe railroad officials were first directed to make these examinations, and utterly failed in finding who were and who were not color-blind, or had defective vision. Then the tests were put in the hands of the railroad surgeons, and they failed in like manner, till they were thoroughly instructed by the only really competent experts, namely, ophthalmic surgeons, familiar with such examinations, and able to understand and discriminate. There has been from lack of expert examinations great waste of time and money. Moreover, the color-blind not detected are thus officially assured of their competency.

Letter from Professor Donders of Utrecht, Holland, chief of the inspection and control of color-blindness and visual power, through Dr. Bouvin, who assists him and is one of the ophthalmic surgeons appointed to test employés:—

UTRECHT, 15, 12, 79.

DEAR SIR, — Herewith you will find the statement of Professor Donders, who always argued, as you have seen in the earlier communications, that the examination should be fulfilled by men who are ophthalmic surgeons, or physicians able to examine the eyes. I believe that the simple statement of Professor Donders will be quite sufficient for your purpose.

With compliments of Professor Donders, yours very respectfully,

BOUVIN.

I most willingly testify that it is my full conviction that only medical experts, ophthalmic surgeons, should be employed in testing color perception and acuteness of vision.

PROFESSOR DONDERS.

UTRECHT, 15 December, 1879.

Letter of Professor Holmgren, of Upsala, Sweden, the originator of all the present movement for control and chief of the control in Sweden; author of the book on color-blindness on which is based Dr. B. Joy Jeffries' "Color-Blindness: Its Dangers and its Detection":—

UPSALA, December 26, 1879.

MY DEAR DOCTOR,—From some recent numbers of the "Boston Advertiser" I learn that the very important matter of testing the color sense of the railroad personnel has been intrusted to some railroad officials. For the last three years this examination has been compulsory with us, and its introduction has hence spread into almost every country. I notice also that you have protested against this, and given your warning, as it seems to me, with perfect right.

The subject is certainly one of the greatest importance. I have been much interested in it, and circumstances have enabled me to have a pretty extended experience on these points. You will pardon me, therefore, from the interest I have in the cause, in expressing myself on this topic.

I am not quite clear that your community understands the importance and necessity of the examinations. I have no doubt of the same, and all Europeans agree with me. On this point I must refer to my own publications, and to the fact that in almost every country the tests have been already more or less introduced. There are naturally people here and there who need more striking examples, in order to be convinced, than really exist. I may be permitted to recall a very peculiarly marked circumstance occurring here in Sweden about two weeks since. I have the following from good authority:—

A locomotive fireman at one end of a private railroad was examined by the railroad surgeon and declared to be completely color-blind. Nevertheless, he was allowed to continue at his work, and he started out as fireman on the next train. The surgeon at once telegraphed the "director of traffic," who was at an intermediate station. The director received the telegram a quarter of an hour before the train was to arrive on which was the fireman. He at once improvised a practical test in this way. He ordered a station-master a few miles farther on to show the "stop signal" (a red lantern), contrary to what was customary, on the side of the road the fireman had his place on the engine. He then got on the engine, and told the engineer not to notice the false "stop signal," but keep boldly on, no matter what happened. Thus prepared, the train went on. The director warned the fireman to carefully watch the signals on his side, and so the train approached the "stop signal." When quite near, the director called out, "Why don't you slow up? Didn't you [to the fireman] see the stop signal?" "No," he quietly replied, "all is clear; the station-master has shown the usual white light." This test was naturally striking and convincing. The consequence was of course self-evident. Arrived at the other end of the road, the director had the fireman tested by another railroad surgeon. He naturally also reported the man to be color-blind, and the fireman was dismissed forever from a locomotive.

This example shows how dangerous it is to let color-blind employés endanger the trains. It shows also that there are cases where the officials can apply a crucial test. These sort of tests do not, however, always succeed, and may, when they fail, affect the official's opinion in just a contrary way from what they did in the case related. If, for instance, by the *action of the engineer* the director's test had failed, then the experiment would only have made him doubt the surgeon's test, and disbelieve in the danger of color-blindness.

I must most decidedly insist that the testing for color-blindness of railroad employés can be safely conducted only by competent persons. In my publi-

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cation of 1877 I have stated this most definitely, and found no cause since then to change my opinion. On the contrary, my subsequent experience has forced me to hold still more closely to this belief. I remarked in my book that at first, here in Sweden, the tests were left to the railroad officials. This, however, soon proved insufficient and useless. For example, one official found amongst his employés ten per cent. color-blind, and this extraordinary ratio figured for a time in the newspapers. It was, however, soon proved to be unfounded. Another official, on the contrary, found little or no color-blindness, and this result was afterwards shown to be equally incorrect.

Medical education is here absolutely necessary. My method is practically so simple that it would seem as if it would be successful in the hands of any physician. In my experience, however, this has never been the case. Time has ever shown that quite competent ophthalmic surgeons have misunderstood it and applied it improperly. In Sweden the railroad surgeons have been practically and specially instructed *de visu*, by me, and we have had every reason to be satisfied with this. There are many cases which *no* railroad official can detect or decide, and not even the ordinary railroad surgeon can be sure of.

I therefore hold, *thirdly*, what I have emphasized in my book, that the authorities must employ a man having the highest special knowledge, who shall be at the head of the control, and (1) to whom all difficult and uncertain cases shall be referred; who thus shall have the final decision as to the employment or not of the particular person; and who (2) shall instruct the railroad surgeons in reference to the detection and control of color-blindness. To him all difficult questions are to be referred. He must be the highest appeal in all concerning this matter.

It has been most fully shown that color-blindness is no simple thing in its various relations to the railroads and the marine. The laity must not therefore feel aggrieved that they have to rely so much upon the authority of experts. I here depend greatly on the intelligence of the general public. Therefore I have given a great many popular lectures. My experience has, however, taught me that the majority, from lack of proper preparatory teaching, can grasp the subject in its details to but an unsatisfactory and insufficient degree. But a thorough knowledge of the *whole subject* is a necessary requisite for the testing the employés.

On the ground of what I have so far said, I must deny the competency of any railroad official to test the color perception of the others. Aside from all other consequences, such practices are dangerous in two ways:—

First, the true color-blind may be overlooked; and this will be practically all the more dangerous since the testing has thus decided their competency, and especially as these undetected color-blind are thus *officially* assured that they can see correctly.

Second, normal eyes may be thus declared color-blind, and hence dismissed from service, which would be unfair in the highest degree. It is but right that every employé should be retained in his position who is thoroughly competent, and this can be determined only by an expert. I must express this more precisely. Only one specially instructed in color-blindness can decide whether the color-sense of an official is sufficiently normal to enable him under each and every circumstance correctly to distinguish the colored railroad signals. I here readily grant that not every normal-eyed person possesses the other qualities necessary for railroad service. These are the requisites of the railroad official. There must, as I have repeatedly emphasized, be a strict line drawn between the competence of the physician and that of the railroad employé. Each has his province, and the border line must not be overstepped on either hand.

The time has long passed for knowing everything. Division of labor is a law

of our times, proving its advance. Railroad traffic is of course here and there a private system. In a certain sense, however, every railroad belongs to all mankind, and must therefore conform to the general public sentiment. The time is not, however, far off when we shall refuse to trust our lives and property to those roads where rules of safety are not thoroughly carried out.

Here in Sweden the practice of medicine is not free. Only those legally authorized can practice. We do not trust to the simple assurance of the butcher that his pork is free of trichinæ, and eat it, but require its being examined and stamped officially by a special expert, etc., etc.

In a word, in European eyes, railroad traffic does not afford the necessary safety unless the color sense of the employés has been tested by competent surgeons and with trustworthy methods.

As to the method, I need not remind that mine with the worsteds has proved preferable to all others. In support of this we have only to compare results obtained by it, and those which the examinations on the German and Austrian roads gave.

Please make as free use of this letter as you may choose. I shall be only too happy to have served your country, as also the mutual traffic of mankind.

Very sincerely yours,

FRITHIOF HOLMGREN.

In an article on examinations for color-blindness, by the distinguished author, Dr. Hugo Magnus, in the "Boston Medical and Surgical Journal" of January 29, 1880, is the following:—

"The great importance which color-blindness possesses in relation to railroads and the safe navigation of vessels is now pretty well recognized over the civilized world. To accomplish the diffusion of this knowledge has cost much labor and the overcoming of many difficulties. It is due to the unremitting efforts of writers of high repute, who have thus finally gained the attention of the authorities to this subject. . . .

"We must express ourselves most decidedly and most earnestly that under all circumstances this should be done only by those capable and experienced, and such are, in the largest majority of cases, ophthalmic surgeons. We do not hesitate to say that on the proper choice of those who are to carry out the test its whole success depends. If the authorities make a mistake in this choice, the value of all the examinations is but questionable. Moreover, the security which the community feels from these tests is undermined. If the examination of the railway personnel is to be of value, the railroad authorities must look to it most carefully that this is placed only in the hands of such persons as from their special knowledge are fitted to undertake it. The examination by medical experts alone guarantees the requisite precision and the consideration of all the possibilities accompanying such examinations.

"It might at first sight seem as if the testing the color sense was a very simple matter, and hence any official, without special knowledge, could be instructed in it. Such a supposition is, however, a grave error, and liable to lead to practical results most dangerous for the life and limbs of the traveling public. . . .

"Our own experience with railroad officials proves most conclusively that cases often enough occur where one or another employé seeks to avoid by feigning the consequences of his detected color-blindness. An examiner who has only the superficial knowledge of the more marked practical indications

will thus be completely at a loss. That such cases will often arise where the employés have learned that an examiner can be *talked over* and *persuaded* may well be believed without our special confirmation or assertion. . . .

"Such uncertain results will follow the authorities employing those who are not experts. A waste of the time and money the examinations have cost. . . .

"Let those who would put these examinations out of the hands of experts pause and consider the responsibility they are assuming. . . .

"Whilst we are not opposed to a practicing physician acting as examiner, provided he has been thoroughly instructed by an ophthalmic surgeon, and the final control and decision is left to the latter, we are entirely opposed to employing those who are not physicians for this testing, no matter what instruction they may have obtained. The laity having no medical preparation, any attempted teaching them the functions of the eye will be most imperfect; they can never thoroughly understand and appreciate them."

(4.) "The board recommends that every railroad company shall have an annual examination of every employé whose duties require or may require capacity to distinguish form or color signals, and that no one shall be so employed who has not been thus examined. The examination should refer to color-blindness and to other defects in vision. It should include all who are in any way concerned in the movement of trains."

In this Dr. Jeffries agreed with the commissioners except as to the necessity of annual examinations. He would propose the carrying out by experts of such regulations as were proposed by Professor Donders, and adopted by the International Medical Congress at Amsterdam last September, as those to be safely recommended to governments and railroad corporations establishing the control of color-blindness and defective sight, here appended as adapted to this country. The tests and report made by him on the only railroad he has been called upon to act for were in accordance with these regulations. Dr. Jeffries proved how equally necessary was *expert* testing in reference to *form perception* as well as the color sense.

(5.) "The board does not recommend any legislation on the subject. The interest of each corporation is strong enough to insure careful examination. Humanity would prevent any company from knowingly employing a person whose defective sight might at any time cause a fatal accident. And self-interest will make railroad managers careful in avoiding even false charges that accidents have resulted from such defects.

"The failure to make examinations heretofore is owing to the want of information on the subject; and, in regard to color-blindness, to the general incredulity as to its existence. Information is now generally diffused and incredulity has ceased, thanks to the efforts of scientific men. And there is no reason to fear that due attention will not be given to the recommendation that all applicants for employment on railroads, and all persons employed, shall be examined for defects."

Against this conclusion Dr. Jeffries argued in behalf of the stockholder and employé. A uniform standard of requirement and method of testing and retesting, alike protective to the community, the stockholders and the employé, can only be secured by all our roads being examined by the same experts with

similar methods of practice in eliminating the defective. It having been shown by experience and experiment that only experts can detect all cases of dangerous color-blindness and defective eyesight, it becomes necessary to enforce on the railroads thorough examinations, and not leave it to the several corporations to employ any one they please to carry these out. This would be most dangerous, as a rejected employé need but seek work on another road. The corporations should hold an authoritative certificate of the possession of normal visual power and freedom from color-blindness for each and every official and employé who has in any way to be called upon to distinguish form or color signals. The delicate position of an *official* in rejecting or retaining an employé he was to decide upon would induce him to refer the question to the expert. The great cost of this would, on the other hand, equally deter him from doing this when he ought to. It would no doubt be *cheaper* for the railroad corporations to pay for expert work sanctioned by the State, whereby they would be protected, and the just demands of the community be met in the only manner they can.

I. GENERAL MEASURES.

There shall be appointed a sufficient number of medical experts whose duty will be to

ART. 1. (a.) Carry out a general examination of all the railroad personnel of the State who are or may be engaged in any duty requiring the distinguishing form or color signals.

(b.) A very careful testing of all new employés.

(c.) A special reëxamination in the cases and under the circumstances indicated in Art. 3, a.

This general examination is to be made but once by the medical experts appointed as examiners.

ART. 2. New employés are only to be engaged who present a certificate of their fitness from one of the medical expert examiners.

ART. 3. A special examination is to be made in reference to

A. *Visual acuteness*, every two years, by a medical expert examiner.

B. The visual power in general (a) at forty-five years of age, and each five years afterwards, by a medical expert examiner; (b) in the special cases, 1st, after any disease of the eyes; 2d, after injuries, namely, such as may have caused commotion of the brain, and after any cerebral trouble; (c) after mistakes or acts which call in question the integrity of the visual functions; (d) when by the periodic reëxamination under A doubt has arisen as to the necessary acuteness.

II. THE EXAMINATION.

ART. 4. The examination is principally of (a) the refraction; (b) visual acuteness; (c) color perception; (d) visual field.

ART. 5. The refraction and visual acuteness will be determined at the same time in the usual way for distance by test types and by glasses, first for each eye separately, and then for both together. When there is slight corneal opacity in the open air.

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ART. 6. For the *qualitative* determination of the color sense Holmgren's method, the color test patterns of Donders, and the pseudo-isochromatic tables of Stilling are to be employed. The quantitative determination is to be made by Donders' method, both by reflected and transmitted light, or by Holmgren's method. Any change from this or the use of other methods shall be determined by the regularly appointed medical experts acting as a board of control.

ART. 7. The visual field is to be tested by mutual fixation of the observed and observer's eyes, and questioning as to the motion of the hands or fingers.

REQUISITES FOR FITNESS.

ART. 8. For the position of locomotive engineer or fireman is necessary (*a*) a certificate of a medical expert examiner of healthy eyes and eyelids, without habitual congestion or inflammation, unrestricted visual field, normal visual acuteness, normal refraction (emmetropia), quantitative color perception at least four-fifths, entire absence of cataract or other progressive disease of the eyes.

For all other positions in railroad service which do or may call for distinguishing form or color signal (*b*) a certificate of healthy eyes and eyelids, without habitual congestion or inflammation, unrestricted visual field in both eyes, normal visual power, normal refraction (emmetropia), and color perception of at least three-fifths in one eye; in the other eye, visual acuteness and color-perception of at least one-half; absence of any trace of cataract or other progressive disease of the eye.

ART. 9. In the reëxamination of engineers and firemen who have been a year or more in such service, *in one eye* visual acuteness of at least three fourths (without glasses) and color perception of at least three-fourths; *in the other eye*, visual acuteness of at least three fourths (without glasses) and color perception of at least one eighth (other requisites as in Article 8, *a*). In the re-examination of all other employés who are or may be called upon to distinguish the form or color signals, who have held their posts for a year or more, there is required unrestricted visual field in one eye at least; in each eye, visual acuteness of at least two thirds, and color perception two thirds. If this visual acuteness and color perception are only attainable by glasses. then these are to be worn (other requisites as in Article 8, *b*).

ART. 10. *Relatively fit* are those whose visual power or color perception for day or night signals is less than two thirds, but above one third. These are to be reported as only partially fit, and to be employed only when they need tell the signals at short distances. *Relative fitness* is not allowable with *engineers and firemen*.

ART. 11. Unfit for all railroad service are those whose visual power and color perception are, with both eyes together, and with glasses, only one third, or less, of the normal.